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NASA for

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ENGINEERING of local

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LUNAR MATERIALS TECHNOLOGY SYMPOSIUM

Proceedings

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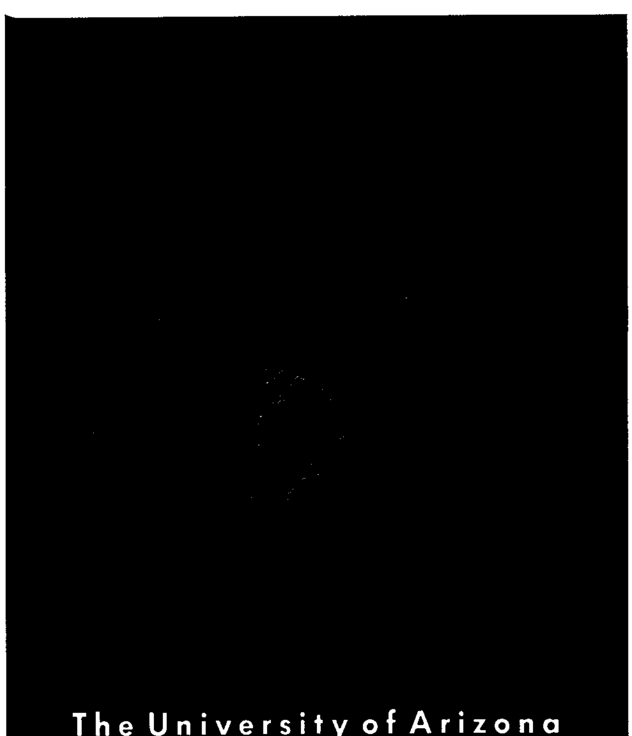

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INTRODUCTION

The Third Annual Symposium of the University of Arizona/NASA Space Engineering Research Center (SERC) was held February 20-22, 1992, in Tucson. Because of common interests in promoting In-Situ Resource Utilization (ISRU) and Indigenous Space Materials Utilization (ISMU), the Symposium was sponsored jointly by the UA/NASA SERC and the Indigenous Space Materials Utilization Advisory Panel, founded by the Lunar and Planetary Institute in October 1990.

The meeting was organized around a possible Lunar Outpost scenario, featuring industrial technologies, systems, and components applicable to the extraction, processing, and fabrication of local materials. Structuring the Symposium in this novel way grew out of discussions between the UA/NASA SERC and the ISMU Advisory Panel. Detailed planning by a subcommittee that included members from both groups resulted in a specific description of an initial Lunar Outpost (reproduced below) in all its aspects, including crew, structural, power, transportation, and supply requirements. Industrial technologies applicable to the processing of local resources were to be stressed.

From this organizational structure grew a most unusual list of participants. In addition to acknowledged space resources experts, the Symposium brought together investigators from outside the field whose knowledge could be applied to space development activities. Presentations came from a variety of specialists in fields such as minerals processing, environmental control, and communications.

The three days were divided into sessions devoted to five major topics; their titles are indicative of the diversity this Symposium offered. The first day opened with a session on *Resource Characterization* that included presentations delivered by experts from NASA Headquarters, Southern Methodist University, the Lunar and Planetary Institute, Bechtel Inc., BDM International, and the Institute for Space Science and Technology. Dr. S. Fred Singer, Distinguished Research Professor with the Institute for Space Science and Technology, delivered a luncheon address on "Project SPACE (Solar Power and Climate Equalizer): SPS Used for Global Climate Modification." The second session of the opening day focused on *Energy Management*; featured were presentations by representatives from Arthur D. Little, Boeing, International Fuel Cells Corp., NASA Headquarters, and NASA Lewis.

The morning session of day two was entitled *Materials Processing*, which brought together specialists from Rockwell International, Bechtel National, EXPORTech Inc., Corning, Electrochemical Tech, Boeing, and UA/NASA SERC. Dr. William L. Smith of NASA Headquarters delivered the luncheon address, "Precursor Missions to Mars." The afternoon session, *Environment Control*, included presentations by experts from Lockheed, NASA Johnson, the Environmental Research Laboratory, Hamilton Standard, and Allied Signal Aerospace. Dr. Louis Friedman, the Executive Director of the Planetary Society, spoke on "International Prospects for Planetary Exploration" at the evening banquet.

Day three opened with a session entitled *Automation and Communications*. Papers were delivered by experts from the National Institute of Standards and Technology, Intec Controls, Westinghouse Electric, Creativision Consulting, and GCI. A *Recommendations* session followed. The distinguished Enabling Technologies Panel consisted of Hubert P. Davis of Davis Aerospace; Benton Clark of Martin Marietta; Murray Hirschbein from NASA Headquarters; Daniel J. Lancaster of Fluor Daniel; John S. Lewis, UA/NASA SERC Co-director for Science; and Gordon Woodcock of Boeing. The luncheon address, "Lunar Materials for the Space Economy" by Dr. James R. Arnold of the

University of California, San Diego, concluded the Symposium. Throughout the three days, *Poster Presentations* from Boeing, Aerojet Propulsion Division, New York University, UA/NASA SERC were available to Symposium participants.

The Third Annual Symposium was clearly successful in achieving its aim. The somewhat unconventional list of experts who spoke provided a refreshing diversity of approaches to some old problems, as well as a variety of new ideas. The format of the Symposium served to introduce specialists representing a wide spectrum of industrial expertise to space resources experts in government and academia. This meeting and others like it may well provide the groundwork for future collaborations to develop extraterrestrial resources. As the recognized meeting place for experts working in the field of space resources development, the UA/NASA SERC will continue to provide opportunities such as this to insure a stimulating and creative exchange of ideas among government, the private sector, and academia.

The following pages contain the papers delivered at the Symposium. Some authors were unable to provide copies of their addresses; in those cases their abstracts have been included in these Proceedings.

-- T. Triffet
Director, UA/NASA SERC

Lunar Outpost Scenario

To focus the presentations it is assumed that: (1) this will be an evolving facility with growing capabilities and needs tended by 5, increasing to 10, astronauts and mission specialists. (2) The initial base will consist of a landing area, a shelter, a solar or nuclear power area, and science and engineering experimental areas. (3) This will require 50 to 100 kw of electrical power; but when permanent occupation begins, probably within two years, a larger habitat and several hundred kilowatts to a megawatt of power will be needed. (4) A utility vehicle that can be used for transporting crew and supplies, as well as for digging, scraping, and lifting, will be available.

(5) The crew will conduct a variety of science and materials utilization experiments. The first of the latter type will include demonstrations of the production of oxygen from soils and rocks, of the extraction and collection of solar wind-implanted gases such as hydrogen, carbon dioxide, and nitrogen, of the fabrication of ceramic bricks, and of the production of various metals and composite materials.

(6) These early basic experiments will be replaced by small pilot plants capable of producing useful amounts of oxygen, volatiles, ceramics, metals, and composites, as well as a few simple products such as bricks of several types, beams, columns, pipes, and membranes.

(7) Oxygen production rates will grow from pilot plant rates of 5-10 tonnes/year to mature plant rates of 25-50 tonnes/year -- enough to fuel a lander to and from lunar orbit. Production of construction materials will grow to rates of hundreds of tonnes/year -- materials that will be used for the construction of shelters, for radiation shielding, for paving landing pads and roads, and erecting blast shields. Eventually local materials will be used to build complete habitats, new power systems, and other essential infrastructure.

Back to the Future

Panel Discussion